165/70

960628 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG.1.

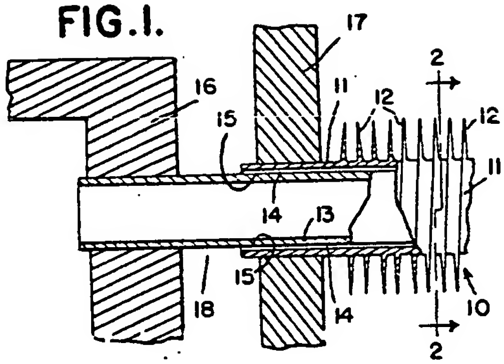


FIG.2.

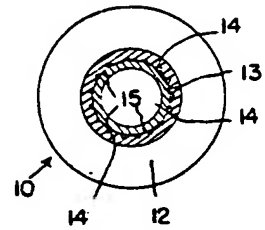
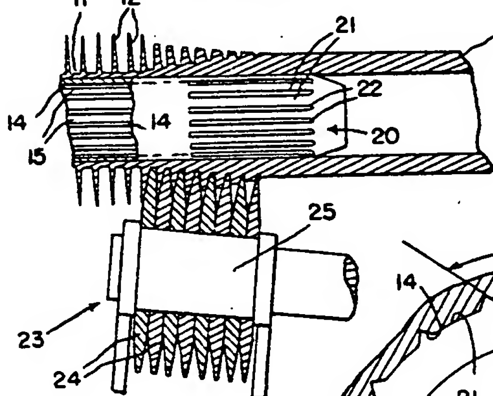


FIG.3.



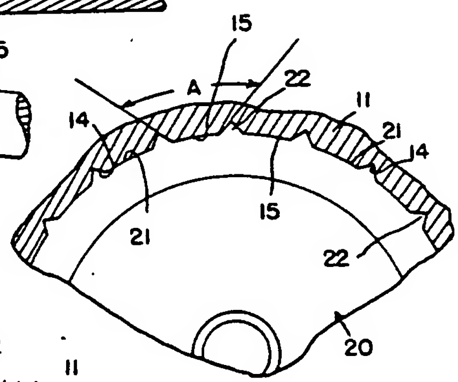
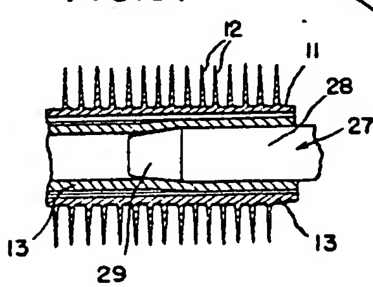


FIG.4.

FIG.5.



PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Leak Detector Tube and Method of Making the Same

We, CALUMET & HECLA, INC., a corporation organized under the laws of the State of Michigan, of 17200 Southfield Road, Allen Park, Michigan, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The present invention relates to improvements in a leak detector tube of the integral finned type, and the method of making the same. Such tube may be employed, for example, in a heat transfer device such as a transformer cooler involving the transfer of heat from transformer cooling oil in which the tube is immersed to cooling water circulated through the interior of the tube. Other applications of the tube, such as in the manufacture of air coolers for naval drive motors, in which a rapid and efficient transfer of heat, such as is characteristic of finned tubing, whether integrally finned or of the bi-metal type, will suggest themselves to those skilled in the art.

Essentially, it is the function of the improved tube to detect any leak which may develop in the tube wall, resulting in the contamination or inter-blending of two fluids between which heat exchange is to take place. To this end, the tube of the invention comprises an outer finned tube and an inner liner tube associated with one another to provide a plurality of axially extending passages between the same, through which a liquid may flow to an exposed point of visible detection, should a leak in one tube or the other develop.

More specifically, in regard to the tube product itself, the invention contemplates the use of an outer finned tube which is provided on its inner surface with a plurality of axially extending grooves of small size, spaced predeterminedly in the circumferential sense relative to one another in a manner to be described, with the inner liner tube in tight contact with the inner surface of the outer tube so as to in effect seal the passages defined by the grooves of the latter from one another. The production of an integrally finned tube for heat transfer, or other purposes, having these characteristics is an object of the invention.

Another object of the invention is to provide an improved method for producing a finned tube of this type, and an integrally finned tube, in an inexpensive and expeditious manner appropriate for mass production at high speed.

In accordance with this method, an externally finned tube is produced having the internal, axially extending grooves referred to above, whereupon a liner tube of slightly lesser outer diameter than the inner diameter of the finned tube, in the spaces between its internal grooves, is inserted into the latter and then expanded into tight sealing contact with the outer tube at such spaces, thus to unite the two tubes tightly.

Another object of the invention is to provide a method in which the external tube may be internally grooved simultaneously with the formation of its integral fins as by subjecting the external tube to the action of suitable progressive finning rollers while the tube is being passed axially over and internally supported by a grooved mandrel.

More specifically, in accordance with the method of the invention, the external tube, finned and internally grooved as described, has an internal liner expanded tightly against its inner surface by drawing an expanding mandrel through the liner to expand the liner and form a tight metal-to-metal bond with the outer tube.

In still further particular in regard to both the tube as a product and the method of making the same, the invention contemplates the provision of leak detector passages, as defined by the grooving of the external tube and its sealed contact with the inner tube at

circumferentially spaced longitudinal areas between such passages, in which the cross-sectional size of the passages is quite small, and not such as to objectionably subtract from the total area of metal-to-metal contact between the two tubes and thus objectionably diminish heat transfer capacity.

With this object in mind, the invention contemplates a sealed contact of the telescoped outer and inner tubes over an area of approximately 60% to 80% of the entire external circumferential area of the inner or non-grooved tube at which the tubes contact, or of such a ratio of the inner circumference of the outer tube should that surface, in an altered embodiment, be the non-grooved one. By further preference, the ratio of metal-to-metal, inter-tube contacting area is in a still higher and more limited range, say 70% to 80% of the total area.

Generally speaking, it is an object of the invention to provide a method of manufacturing leak detector tubes of the type referred to which assures a maximum heat transfer capacity of the product in the way referred to above, and which insures a uniform expansion of the inner tube for a controlled metal-to-metal contact with the outer, i.e., without distortion of the grooving defining the leak detector passages, or of extrusion of metal of the expanded tube into the grooves, such as might result in the blocking of any thereof.

The foregoing will become more apparent as this description proceeds, especially when considered in connection with the accompanying drawing illustrating the invention, wherein:

Figure 1 is a fragmentary, more or less schematic view, partially broken away and in longitudinal cross-section, showing the improved leak detector tube of the invention as employed in a typical application, i.e., an installation of the tube as a heat transfer element associated with an oil-type transformer;

Figure 2 is a view in transverse vertical section along line 2—2 of Figure 1;

Figure 3 is a fragmentary view in longitudinal or axial section illustrating a method and apparatus employed for the simultaneous provision of an external tube component of the improved leak detector tube of external heat transfer finning and internal, longitudinally extending leak detector groove and rib formations;

Figure 4 is a fragmentary view in enlarged scale showing a portion of a ribbing tool or mandrel component of the apparatus of Figure 3; and

Figure 5 is a fragmentary view in longitudinal or axial section illustrating a further procedure in the method of the invention, by which an inner liner tube is fixedly associated with an external finned tube to provide the desired longitudinal leak detector passages between the tubes.

Figure 1 of the drawing illustrates a typical installation of the improved tube, generally designated 10, of the invention as a heat transfer component of an oil transformer. Tube 10 comprises an external elongated tube member 11 of cylindrical cross-section having radially outwardly extending rib formations 12 formed thereon, in a manner to be described. An internal tube member 13 is telescoped within and fixedly associated with the tube 11, also in a manner to be described; and between these tube members there exist a plurality of longitudinally and axially extending leak detector passages of very small cross-sectional area, such passages being designated 14 and being separated from one another in the circumferential sense by longitudinally extending spaces or lands 15, at which the external periphery of the internal tube 13 is in tight sealing engagement with the inner periphery of the outer tube.

The reference numeral 16 designates, in an installation of this type, a water-side wall or sheet, as the wall of a manifold from which cooling water is discharged for circulation within and along the inner tube member 13; while the reference numeral 17 designates an oil-side wall or sheet, such as the wall of a container of the transformer filled with oil in which the tube 10 is immersed, with its external fins 12 submerged in heat receiving and transfer relation to the oil.

As shown in Figure 1, the inner tube member 13 extends outwardly beyond the outer tube member 11, being received in and extending through the water-side sheet or wall 16, with a leak-proof seal thereto. The outer tube member 11 is similarly received in the oil-side sheet or wall 17, terminating short of the wall 16 in a space 18 between walls 16, 17, at which space any leakage from a grooved aperture or apertures 14 of the tube 10 is readily detected visually or otherwise, so that immediate steps may be taken to correct the situation, as by replacing or repairing a damaged tube 10.

Although the passage-defining grooves 14 may be formed about the inner periphery of tube member 11 prior to the formation of its external ribs 12, integral therewith or otherwise, the invention contemplates the simultaneous formation of the ribs and grooves, employing apparatus of the type illustrated and described in our U.K. Patent No. 673,818 of May 5, 1958, however employing in lieu of smooth-surfaced forming mandrel of that patent a mandrel, here designated 20, which is provided about the periphery thereof and adjacent a forward nose with a plurality of elongated, axially extending grooves 21 separated by radialyl outwardly projecting ribs 22.

Figure 3 of the drawings illustrates but schematically the general nature of the form-

ing mandrel 20, and Figure 4, in considerably larger, and in fact exaggerated, scale better shows the approximate proportioning of the grooves 21 and ribs 22 of the mandrel. Thus, if it be assumed that the unformed tube T to be employed is of .620 inch inner diameter, the outer diameter of mandrel 20 will be the same, in the zone therealong at which the grooves and ribs are formed, and the ribs 22 will extend radially outwardly therefrom approximately .018 inch, the O.D. of the tool across a pair of diametrically opposed ribs 22 being then .656 inch. The ribs are of generally triangular outline, although flattened or truncated slightly at their apices; and the circumferential spacing from the root of one rib to the root of the next rib is approximately .062 inch. The angle A included between adjacent, divergent sides of successive ribs 22 amounts to approximately 90%.

It is to be understood that the mandrel 20 depicted in Figure 4 and described above as to dimension is merely typical; and the dimensions are not at all definitive but simply illustrative of the proportions which will produce the desired contact area of the outer surface of the inner tube member 13 with the spaces or lands 15 of the outer tube, and the desired cross-sectional area of the passages or grooves 14.

Proportions may be altered, depending upon tube diameter, wall thickness and other like considerations. However, it follows that if a mandrel 20 is employed of the type described, the outer tube member 11 will have on its inner circumferential surface a circumferentially spaced series of the passage-separating lands or spaces 15 which individually approximate .062 inch in circumferential extent. Assuming that the mandrel 20 is designed to produce 20 such lands at the grooves 21 of the mandrel then for a tube of .620 inch I.D. the lands 15 will occupy a total of 1.240 inch of circumference. With the outer diameter of inner tube member 13 tightly engaged against such lands, hence being of ultimate .620 inch dimension, the outer circumference of the inner tube member is 1.958 inch. This signifies that the total area of contact between inner and outer tubes at the lands 15 amounts to about 63% of the outer peripheral area of the inner tube member.

This in turn signifies that a maximum heat transfer contact between the tubes is insured, while still providing adequate cross-sectional area of the leak detector passages 14 of tube 10. The ratio may vary, of course, but the provisions are such as to insure a range of, say, 60% to 80% of total contact area, with the usual ratio between 60% and 70%.

As illustrated and described in the Patent identified above, a tool 23 for progressively forming the integral fins 12 of the outer tube member 11, while at the same time in conjunction with mandrel 20 forming the lands 15 and grooves 14 on the interior of the tube, may comprise a series of progressively thinner forming disks 24 assembled axially upon a suitable arbor 25, by which they are pressed against the outer periphery of unformed tube T upon relative rotation of the latter and the tool 23, to eventually provide a helical fin formation of which successive convolutions will constitute the fins 12 of the improved tube.

There are preferably three of the tools 23 equidistantly spaced circumferentially relative to the axis of the tube, and as described in Patent No. 673,818 the disks 24 are of progressively increasing thickness at their working edges, in the direction in which the unformed tube T passes over the mandrel 20, i.e., from right to left as shown in Figure 3. As also illustrated in that Patent, the axis of the tool 25 is inclined relative to the axis of the tube T to produce the fins 12.

Due to the fact that the material of the tube T takes embedding engagement with the mandrel 20 in passing thereover, it will be necessary to either provide for the rotation of the respective forming tools 23 about the axis of the tube as forming proceeds, or to provide for rotation of the mandrel 20 with the tube as the latter passes over it.

In any event, upon termination of the finning and grooving procedure, a tube 11 results which has an external helical fin formation providing heat absorbing fins 12 of substantial exposed area, to the interior of which tube the inner tube member 13 is tightly assembled in the manner now to be described, reference being had to Figure 5 of the drawing.

For this purpose, a forming mandrel 27 is employed which is externally smooth, both along its cylindrical body 28 and its forwardly tapered nose portion 29. The inner tube member 13 is initially of an outer diameter somewhat less than the inner diameter of the outer tube member 11 at its lands 15, as shown in Figure 5, enabling the inner member to be readily slipped coaxially within the outer member. As thus assembled, the inner and outer tube members are drawn forcibly over the forming mandrel 27, i.e., from left to right as illustrated in Figure 5; and the outer diameter of the body 28 of the mandrel is sufficient to cause the inner tube member to be expanded into tight sealing contact with the internal lands 15 of the outer tube. In this, proportioning of the tool 27 as to size in relation to the tube members 11 and 13 is important, for it is undesirable that sufficient pressure be exerted upon the lands 15 to cause any appreciable distortion thereof, or, more important, to extrude the material of the inner tube member into the grooves or passages 14, thus at least in part blocking the latter.

The tube members 11, 13 may be of any of the usual ductile and non-ferrous material

commonly employed in finned tubing. The tube 10 is a rugged and tightly assembled unit, capable of production in any desired length in a very economical manner.

The drawing and the foregoing specification constitute a description of the improved leak detector tube and method of making the same in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

WHAT WE CLAIM IS:—

1. A leak detector tube structure comprising an elongated normally imperforate outer tube member provided with integral circumferential finning extending radially outwardly and along the length thereof to provide longitudinally spaced finned portions, and a normally imperforate inner tube member telescoped coaxially in said outer tube in fixed relation thereto, one of said tubes having longitudinally extending formations on one surface thereof at which it is in tight radial engagement with the other tube, said formations extending substantially from end to end of the tube structure and defining circumferentially spaced, longitudinally extending leak detector passages between the tubes.

2. A tube structure in accordance with Claim 1, in which said outer tube member is formed to provide an external helical fin formation, and in which said formations include longitudinally extending grooves on said one tube circumferentially spaced by longitudinally extending land formations.

3. A tube structure in accordance with Claim 2, in which said grooves and land formations are formed on the inner surface of said outer tube.

4. A tube structure in accordance with Claim 3, in which said inner tube has a plain surfaced periphery engaged with the interior of said outer tube at said land formations.

5. A tube structure in accordance with Claim 1, in which the total area of said formations at which they engage said other tube approximates 60%—80% of the total area of said last named tube at the surface engaged by the formations.

6. A tube structure in accordance with claim 1, in which the total area of said formations at which they engage said other tube approximates 60%—70% of the total area of said last named tube at the surface engaged by the formations.

7. A tube structure in accordance with claim 2, in which the total area of said land formations at which they engage said other tube approximates 60%—80% of the total area of said last named tube at the surface engaged by the formations.

8. A tube structure in accordance with claim 2, in which the total area of said land formations at which they engage said other tube approximates 60%—70% of the total area of said last named tube at the surface engaged by the formations.

9. A tube structure in accordance with claim 2, in which the total area of said land formations at which they engage said other tube approximates 60% of the total area of said last named tube at the surface engaged by the formations.

10. A method of producing a leak detector tube structure of the kind having inner and outer tubes telescoped relative to and tightly engaged with one another at axially extending meeting surfaces which are separated by circumferentially spaced, axially extending leak detector passages of small circumferential width in comparison with that of said meeting surfaces; comprising providing a pair of inner and outer tubes of which the diameter of the outer surface of the inner is slightly less than the diameter of the inner surface of the outer; subjecting one of said tubes to a rolling operation to simultaneously provide circumferentially extending radial formations on one of its surfaces and circumferentially spaced radial formations on the other surface which extend lengthwise of said one tube, placing the inner tube within the outer, and treating said tubes to cause them to take tight radial meeting engagement with one another in zones between said circumferentially spaced radial formations, which zones represent said axially extending meeting surfaces of the tube structure.

11. A method in accordance with claim 10, wherein said circumferentially spaced radial formations are formed on the inner surface of said outer tube.

12. A method in accordance with claim 11, said inner tube having a plain outer surface in engagement with said lands.

13. A method in accordance with claim 10, 11 or 12, wherein the aggregate circumferential dimension of said zones approximates 60%—80% of that of the outer periphery of the inner tube when the latter is expanded.

14. A leak detector tube structure substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawing.

15. A method of producing a leak detector tube, the method being substantially as hereinbefore described with reference to Figures 3 to 5 of the accompanying drawing.

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